GEORGIA INSTITUTE OF TECHNOLOGY
OFFICE OF CONTRACT ADMINISTRATION
SPONSORED PROJECT INITIATION

Date: 8/25/78

Project Title: The Recruitment and Retention of Women in Engineering: Development of Policy Guidelines

Project No: E-24-676

Project Director: Dr. T. Connolly

Sponsor: DHEW/Office of Education

Agreement Period: From 8/1/78 Until 7/31/79 (Budget Period)
(8/1/77 - 7/31/79 Project Period)

Type Agreement: Grant No. G007701740, Revision No. 1, dated 7/10/78

Amount: $10,567

Reports Required: Final Program Performance Report

Sponsor Contact Person (s):

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NOTE: CONTINUATION OF E-24-660

Defense Priority Rating: n/a

Assigned to: Industrial and Systems Engineering (School/Laboratory)

COPIES TO:

Project Director
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✓Library, Technical Reports Section
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Project File (OCA)
Project Code (GTRI)
Other

CA-3 (3/76)

GEORGIA INSTITUTE OF TECHNOLOGY
OFFICE OF CONTRACT ADMINISTRATION

SPONSORED PROJECT TERMINATION

Date: 2/15/80

Project Title: The Recruitment and Retention of Women in Engineering: Development of Policy Guidelines

Project No: E-24-676

Project Director: Dr. T. Connolly

Sponsor: DHEW/Office of Education

Effective Termination Date: 7/31/79

Clearance of Accounting Charges: 7/31/79

Grant/Contract Closeout Actions Remaining:
None

_ Final Invoice and Closing Documents
_ Final Fiscal Report
_ Final Report of Inventions
_ Govt. Property Inventory & Related Certificate
_ Classified Material Certificate
_ Other ______________

Assigned to: Industrial & Systems Engineering (School/Laboratory)

COPIES TO:

Project Director
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✓Library, Technical Reports Section
EES Information Office
Project File (OCA)
Project Code (GTRI)
Other ______________

CA-4 (1/79)

FINANCIAL STATUS REPORT

(Follow instructions on the back)

1. FEDERAL AGENCY AND ORGANIZATIONAL ELEMENT TO WHICH REPORT IS SUBMITTED	DHEW Office of Education
2. FEDERAL GRANT OR OTHER IDENTIFYING NUMBER	G007701740
OMB Approved No. 80-R0180	PAGE 1 OF 1 PAGES
3. RECIPIENT ORGANIZATION (Name and complete address, including ZIP code)	Georgia Institute of Technology Atlanta, Georgia 30332
4. EMPLOYER IDENTIFICATION NUMBER	58-6002023
5. RECIPIENT ACCOUNT NUMBER OR IDENTIFYING NUMBER	E-24-676
6. FINAL REPORT	[X] YES [ ] NO
7. BASIS	[X] CASH [ ] ACCRUAL
8. PROJECT/GRANT PERIOD (See instructions)	FROM (Month, day, year) 8/1/77 — TO (Month, day, year) 7/31-79
9. PERIOD COVERED BY THIS REPORT	FROM (Month, day, year) 8/1/78 — TO (Month, day, year) 7/31/79

10. STATUS OF FUNDS

PROGRAMS/FUNCTIONS/ACTIVITIES ▶	(a)	(b)	(c)	(d)	(e)	(f)	TOTAL (g)
Net outlays previously reported	$	$	$	$	$	$	$ 26,604.71
Total outlays this report period							9,865.20
Less: Program income credits							-0-
Net outlays this report period (*Line b minus line c*)							9,865.20
Net outlays to date (*Line a plus line d*)							36,469.91
Less: Non-Federal share of outlays							3,359.98
Total Federal share of outlays (*Line e minus line f*)							33,109.93
Total unliquidated obligations							-0-
Less: Non-Federal share of unliquidated obligations shown on line h							-0-
Federal share of unliquidated obligations							-0-
Total Federal share of outlays and unliquidated obligations							33,109.93
Total cumulative amount of Federal funds authorized							38,067.00
Unobligated balance of Federal funds							4,957.07

11. INDIRECT EXPENSE

a. TYPE OF RATE (Place "X" in appropriate box)	[ ] PROVISIONAL [X] PREDETERMINED [ ] FINAL [ ] FIXED		
b. RATE	c. BASE	d. TOTAL AMOUNT	e. FEDERAL SHARE
76%	Salaries & Wages	13,196.49	11,836.50

12. REMARKS: *Attach any explanations deemed necessary or information required by Federal sponsoring agency in compliance with governing legislation.*

13. CERTIFICATION

I certify to the best of my knowledge and belief that this report is correct and complete and that all outlays and unliquidated obligations are for the purposes set forth in the award documents.

SIGNATURE OF AUTHORIZED CERTIFYING OFFICIAL: David V. Welch

DATE REPORT SUBMITTED: 1/10/80

TYPED OR PRINTED NAME AND TITLE: David V. Welch, Manager, Grants & Contracts Accounting

TELEPHONE (Area code, number and extension): 404/894-4624

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1/2/80

Dr. T. Connolly Assoc. Prof. Date

E-24-676

FINAL REPORT

THE RECRUITMENT AND RETENTION OF WOMEN IN ENGINEERING: DEVELOPMENT OF POLICY GUIDELINES

By

Terry Connolly and Alan L. Porter

DECEMBER 1978

GEORGIA INSTITUTE OF TECHNOLOGY

SCHOOL OF INDUSTRIAL & SYSTEMS ENGINEERING

ATLANTA, GEORGIA 30332

1978

FINAL REPORT

THE RECRUITMENT AND RETENTION OF WOMEN IN ENGINEERING: DEVELOPMENT OF POLICY GUIDELINES

Terry Connolly

Alan L. Porter

Georgia Institute of Technology

December 1978

CONTENTS

Grantee Organization:

Georgia Institute of Technology
225 North Avenue
Atlanta, Ga 30332

Grant No: G007701740

Project Director:

Terence Connolly
School of ISyE
Georgia Institute of Technology
Atlanta, Ga 30332

Phone: (404) 894-3933

Starting Date: August 1, 1977

Ending Date: October 31, 1978

No. of Months: 15

Grant Award:

Year 1: $27,500

Year 2: $10,567

Project Title: THE RECRUITMENT AND RETENTION OF WOMEN IN ENGINEERING: DEVELOPMENT OF POLICY GUIDELINES.

FINAL REPORT

Project Title: THE RECRUITMENT AND RETENTION OF WOMEN IN ENGINEERING: DEVELOPMENT OF POLICY GUIDELINES

Grantee: Georgia Institute of Technology
School of ISyE
225 North Avenue
Atlanta, Ga 30332

Project Director: Professor Terence Connolly
Phone: (404) 894-3933

EXECUTIVE SUMMARY

Engineering has traditionally been almost entirely a male profession. As recently as 1970, only about 1% of undergraduate engineering degrees awarded in this country went to women. In recent years, however, the situation has been changing very rapidly. As of Fall, 1977, women represented 10% of the full-time undergraduate engineering students, and a still larger fraction of the entering class. This rapid growth, while geographically very widespread, has been highly variable between schools. Several schools have seen their female enrollments grow to 20% or more of their full-time undergraduate student body, while others remained at the traditional 1-2% women. The present study explores the causes of this variability between schools in their enrollments of women students. Specifically, it addresses the question: What can be done by an engineering college dean to facilitate the entry and retention of women in undergraduate engineering programs?

The Policy Recommendations offered (Attachment I) are based on a number of project activities. The study drew on a body of previous research (by ourselves and others), and was under the general guidance of an Advisory Panel, comprising both researchers and practitioners in the area. Three

main research activities were undertaken: (a) an analysis of enrollment changes at all U.S. engineering schools between 1972 and 1976, drawing on published sources; (b) a focussed study of the women-oriented activities at sixty schools, representing the thirty most-successful and thirty least-successful schools in attracting women, with data generated by a combination of questionnaire and telephone interviews; and (c) an in-depth study of one rather successful program, drawing on questionnaires completed by entering men and women students before and after their first year of study, and on interviews with school officials involved with women-oriented programs.

The major conclusion to emerge from these analyses is that the design of an effective women-oriented program is a complex problem. There is no single key to its solution, nor is there a single approach effective for every school and setting. Rather, the success of such programs appears to be determined by the extent to which they address two underlying mechanisms, offered here as hypotheses:

1. The Decision-Support Hypothesis: Engineering is a high-uncertainty choice of major for a woman student, with implications and consequences hard for her to assess. Thus at each of the major decision points from high-school through professional practice, a woman needs more decision support than does a man if the choice of engineering is to remain a realistic option.

2. The Positive Feedback Hypothesis: For several reasons, schools which currently have large enrollments of women face fewer difficulties in subsequent recruiting than do those recruiting substantial numbers of women for the first time. Successful programs thus tend to be self-reinforcing, while unsuccessful programs tend to face persistent problems.

In designing an effective program aimed at women, then, the administrator must first assess the school's current performance. If current enrollment is less than 10% women in the entering class, the school is substantially lagging national trends in this regard, and may wish to mount an intensive, focussed effort to 'break in' on the positive feedback loop. Women enrollments in excess of 15-20% would suggest more of a 'growth maintenance' strategy, in which sustained but less intensive effort should maintain the school's gains in this area. Detailed recommendations for strategies of both kinds are offered in Attachment I of this Report.

Attachment I has been mailed to every engineering college in the U.S., supplementing the normal dissemination of research results through the scholarly literature. The long-run impact of the study is, of course, dependent on the extent to which these proposals are implemented by college administrators. We hope to be able to monitor such implementation and the impact on enrollments of women engineering students over the next several years. The demonstration of such an impact would, we believe, be of considerable value not only in the field of engineering education, but also as a source of insight and effective intervention in a variety of other 'non-traditional' career areas for women.

In addition to the Policy Guidelines offered in Attachment I, a more detailed overview of the research results is attached (Attachment II). Further focussed analyses of specific parts of the data are in progress; reports of these may be obtained from the authors.

I: PROJECT DESCRIPTION.

a: Background: During the early and middle 1970s, the numbers of women students entering undergraduate engineering programs in the U.S. underwent a dramatic and continuing increase. As recently as 1970, women represented only about 1% of all recipients of undergraduate engineering degrees, a figure which had remained unchanged for many years. By Fall of 1977, women represented fully 10% of the full-time undergraduate engineering students in this country, and over 11% of the entering class. Undergraduate engineering education (and by implication the engineering profession) thus represents the only professional area we know of in which the representation of women has increased by an order of magnitude during this time frame. The phenomenon is of considerable interest, both of itself and in terms of the insight it might provide for other 'non-traditional' career areas for women.

The focus of the present study was on the role of the individual engineering schools in stimulating this growth. Specifically, a preliminary analysis of enrollment trends showed that the growth in percentage of women was geographically widespread, but was extremely variable from school to school. As of 1976, the ten schools most successful at attracting women were approaching 20% women in their full-time undergraduate student body; the ten least successful schools (excluding military academies) remained below 2%. Our assumption was that at least part of this variation between schools was the result of differences in their recruiting strategies and other women-oriented activities. The aim of this study, then, was to identify specific activities and strategies which, if implemented by a given school, showed promise of increasing the entry and retention of women students in undergraduate engineering programs.

b. Study Design: As originally proposed, the study was to include three major elements: (i) an analysis of enrollment trends between 1972 and 1976 for all

U.S. engineering schools, using published data; (ii) a focused study of the 50 schools most successful in attracting women (as reflected in their 1976 enrollments), with data gathered both from published sources and from telephone interviews with administrators at each school; and (iii) an in-depth study of one rather successful program, that at Georgia tech, drawing on questionnaire data from both men and women, at entry and at the completion of the first year of study, and on interviews and documents from staff and faculty involved with women-oriented programs. In addition to these data-gathering efforts, the design included a survey of existing literature, and the establishment of an Advisory Committee of six administrators and researchers who would help guide the study and review its outcomes.

Two significant changes were made in this design as the study developed. First, the sample design in part (ii), the focussed study, was changed from the 50 most-successful schools to a contrast sample of the 30 most-successful and 30 least-successful schools, further stratified by school size (into small, medium, and large engineering programs). This modification improved both the analytic clarity of the results (by allowing direct comparison of successful and unsuccessful programs) and the generalizability of the findings (by allowing statistical control for school size). A second change from the proposed design was the addition of data from a survey published by the American Society for Engineering Education of women-oriented activities at over 100 engineering schools. We were unaware of the existence of this survey at the outset of the study, and found it a useful if imperfect addition to our available data. With these exceptions, the study was conducted essentially as originally proposed.

While the study as conducted was quite close to that initially proposed, our initial assessments of the quality and availability of various types of data were often substantially in error. In general, we underestimated the time and effort involved in collecting several types of data, and over-estimated its likely quality. The most serious slippage occured in the telephone interviews with engineering college administrators, from which we hoped to gather data both on enrollment patterns and changes at each school, and specific detail of the women-oriented activities at each. A total of 4 person-weeks of professional effort was budgeted for the development and mailing of the relevant questionnaires, and for the conduct of the telephone interviews. In the event, this estimate was low, perhaps by an order of magnitude: this phase of the work extended over six calendar months, and involved at least part-time work from five individuals. The telephone interviews, in particular, turned out to be a most difficult means of collecting reliable information. College administrators were often difficult to contact (requiring, in one case, 14 different long-distance calls). We were frequently referred to officials less well-informed than we hoped. Several of the classes of data we sought (for example, drop-out rates for men and women) were simply not available in most cases. And some of our respondents, particularly those at less-successful schools, were evasive and non-specific when pressed on the details of their women-oriented activities. In short, the combination of questionnaires and structured telephone interviews which we planned for part (ii) of the study turned out to be considerably more costly of time and effort, and somewhat less productive in terms of resulting data breadth and quality, than we had initially expected. In retrospect, a larger fraction of the study budget should have been allocated to this part of the work, and less yield of high-quality data expected. (On the other hand, the approach still appears more cost-effective than the alternative of a series of on-site interviews, with the considerable travel costs this would require.)

In summary, the study design originally proposed was found to be basically a serviceable one and, with the two additions noted above, guided the study well. In retrospect, however, we would have to conclude that our original budget estimates were too low. Even with an extension of one calendar month, and an additional $6,000 of additional funding provided by FIPSE, over the original plan, the study would not have been brought to completion without a considerably input of unrecompensed effort from the research team.

II: PROJECT RESULTS.

The primary output from this study is the document included as Attachment I to this Report, entitled: "Women in Engineering: Policy Recommendations for Recruitment and Retention in Undergraduate Programs". This document, which has been mailed to all engineering schools in the U.S., gives a brief overview of the current status of women in engineering programs, a summary of the present study and, most importantly, a set of policy recommendations providing specific suggestions as to what should be done by an engineering college dean wishing to increase the enrollment of women in his or her undergraduate program. It is our belief that this document, in its brevity, action-orientation, empirical support, and direct accessibility to engineering-school deans, offers the best prospect for a direct impact from this study on the development of effective women-oriented programs in engineering colleges, and thus on the numbers of women engineering students.

In addition to this direct-mail approach to dissemination we are, of course, following the normal channels of scholarly publication. One paper, a report of the major findings from the study, is included here as Attachment II. (It is presently under review for publication in Engineering Education.) We are preparing a paper on the first-year socialization experiences of the woman engineering undergraduate. A preliminary version will be presented at the annual conference of the American Society for Engineering Education in June 1979, with a later version to be published. We are thus moving to bring the results and implications of the study both directly to the attention of relevant users (engineering college deans) and to the wider research community.

We will not attempt to summarize the detailed findings and implications of the study here, since they are reported in the two Attachments to this Report. We would, however, like to offer one general conclusion. It is that the rapid entry of women into undergraduate engineering education in recent years is a complex social phenomenon; and that, as a result of this complexity, the discretionary role of engineering schools in facilitating such entry is smaller than we initially expected. The original proposal conveys a sense of hubris, an implication that the study would uncover a small number of key activities which, if implemented, would make a decisive impact on woman enrollments at any given school. The data, in contrast, argue for rather more humility. Certainly, we would expect that careful and persistent attention to the concerns summarized in Attachment I should achieve a substantial long-run impact. We do not, however, expect such achievement to come immediately from implementation of a few low-cost, low-effort standard tricks. Rather, we see a high-impact women-oriented program as requiring substantial, ongoing effort on the part of the school, addressing a wide range of interconnected issues, and tailored by continuing experimentation to the needs and opportunities of each individual school. Obviously, we believe the effort is justified. But we do not believe that instant success will be achieved by merely introducing one or two magical devices.

III: ACHIEVEMENTS AND SHORTCOMINGS.

The ultimate aim of the present study is to facilitate entry into, and retention in, engineering programs for women. Obviously, we cannot at this point assess our success in achieving this long-term goal. We can, however, specify the process which is required in reaching the goal, and assess the achievement of those steps which are completed thus far.

a. Research adequacy: The first requirement is that the research elements of the study be competently conducted. This includes the research design and data collection, analysis, and drawing of appropriate inferences. Our assessment here is positive: we believe the study was conducted to good professional standards, an assessment reflected in the concurrence of our Advisory Committee and (we hope) in the judgement of professional colleagues reviewing the research papers flowing from the study. While no empirical study is perfect, we believe this one to be of a competent and careful professional standard.

b. Supportable recommendations: The second necessary process step is that the research understanding gained be translated into action recommendations with demonstrable potential impact. Again, our assessment here is positive. We believe that the recommendations offered in Attachment I are firmly based in the research findings. Further, they are in tune with the practical experience of the members of our Advisory Committee who have been involved in women-oriented activities for women engineering students.

c. Adequate dissemination: The third necessary step is that the recommendations be brought to the attention of the relevant user audience. We believe that the dissemination plan of direct mailing to engineering college deans plus normal publication channels should serve this requirement adequately.

d. <u>Acceptance and adoption</u>: We have at present no data bearing on the extent to which the user audience of engineering deans finds the recommendations acceptable, or intends to adopt them. A brief questionnaire addressing these questions was included in the national mailing of Attachment I, as was an order form for the full study report (Attachment II). Questionnaire responses and requests for the full report will provide some indication of the user audience's response. Other indications will be the number of inquiries received in response to this mailing, requests for article reprints, citations of our papers in subsequent research, and so on. These data are not presently available.

e. <u>Evidence of impact</u>: The final and most critical element in assessing the success of this study will be the 'hard numbers' -- evidence that at least some of the potential user audience actually implemented at least some of our recommendations, and that their enrollments of women subsequently increased. Needless to say, evidence of such impact is not yet available.

In short, to the extent to which we are now able to assess this work, we judge it to be a success. While far from perfect, the empirical research is solid, it has been successfully translated into supportable action recommendations acceptable to professional peers, and the recommendations have been widely disseminated to the potential user audience. Unfortunately, this assessment must stop short of the two critical questions: will the recommendations be accepted and adopted by the potential users? and will they bring about positive impact if they are implemented? Evidence bearing on either of these questions will, inevitably, be some time in coming.

WOMEN IN ENGINEERING: POLICY RECOMMENDATIONS FOR RECRUITMENT AND RETENTION IN UNDERGRADUATE PROGRAMS

Terry Connolly
Alan L. Porter
Georgia Institute of Technology

September, 1978

E-24-676

WOMEN IN ENGINEERING: POLICY RECOMMENDATIONS FOR RECRUITMENT AND RETENTION IN UNDERGRADUATE PROGRAMS

Terry Connolly
Alan L. Porter

Georgia Institute of Technology

September, 1978

This report addresses the question: What can be done by an engineering college dean to facilitate the entry and retention of women in undergraduate engineering programs? We offer policy guidelines and recommendations which, we believe, will assist engineering college administrators in achieving this end. In formulating these proposals, we have drawn on a number of resources: previous research (by ourselves and others); the guidance of an Advisory Panel, representing both researchers and practitioners in the area; and a new study just completed which has included an analysis of enrollment changes at all U.S. engineering schools between 1972 and 1976, a focussed study of thirty most-successful and thirty least-successful programs in attracting women, and an in-depth study of one rather successful program (Connolly and Porter, 1978). (A full report of this study is available from the authors.)

Drawing on this diverse body of materials, this report presents:

A. a brief summary of the present status of, and likely future trends in, the enrollment of women in undergraduate engineering programs;

B. what we see as the two key mechanisms underlying the success or failure of an engineering school's women-oriented programs; and

C. a set of action proposals for engineering college administrators.

A. Present Status of Women in Undergraduate Engineering Programs

Historically, the engineering profession has attracted only tiny numbers of women. As recently as 1970, only about 1% of undergraduate engineering degrees awarded in this country went to women, with still smaller fractions receiving advanced degrees. However, since the early 1970's, this situation has been changing very rapidly (see Figure below). As of Fall 1977, women represented 10% of full-time undergraduate (FTUG) engineering students, and over 11.2% of the entering class. In actual numbers, the growth in full-time undergraduate students has been from

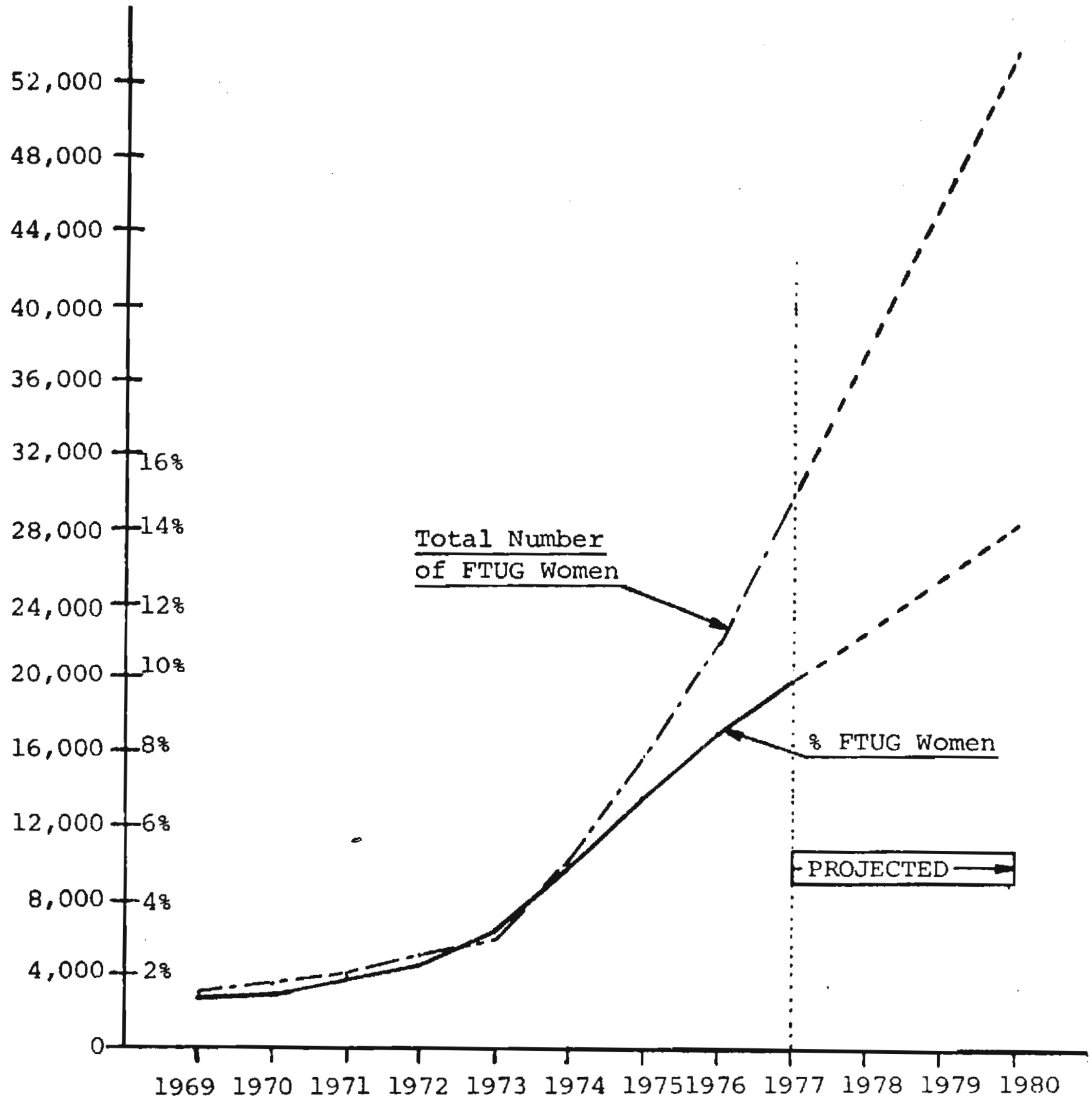

Figure 1: Total Numbers, and Percentage, of Full-Time Undergraduate (FTUG) Women in U.S. Engineering Schools, 1969-1977

(Source: EJC/EMC, Ref.1)

around 4,000 women in Fall, 1971 to almost 22,000 (Fall, 1976) and 29,000 in Fall, 1977 (see Reference 2). Assuming this trend continues, we project about 54,000 FTUG women, roughly 14 % of all FTUG engineering students in the U.S., by Fall, 1980.

This gain has not been one of numbers alone. The women now entering undergraduate engineering programs are academically very able, typically as strong as, or stronger than, their male counterparts. One researcher (Ott, 1978) reviewing a range of indicators of academic ability, concludes that "women engineering students are among the best qualified students at U.S. universities," a conclusion echoed by our own data. Further, there are indications that these women often tend toward positions of campus leadership in student government, professional honorary societies, and so on. Regardless of other possible motivations, any dean concerned with the academic quality of a school's engineering students has a thoroughly pragmatic reason for seeking women: they are excellent students.

The movement of women into engineering has not been confined to one or two areas of the country. It has, rather, been a broadly-distributed national phenomenon. For example, the Fall, 1976 national average was 8.5% women. Only four states (Maine, 4.6%; South Carolina, 4.9%; Nebraska, 4.9%; and Utah, 4.8%) fell below 5% women in their engineering schools; and only eight states exceeded 10% (Delaware, 11.4%; Pennsylvania, 10.8%; Michigan, 10.5%; Georgia, 10.4%; Tennessee, 10.8%; Missouri, 10.6%; Montana, 10.6%; and Nevada, 10.4%). The trend, then, is geographically widespread; and state-to-state variance is modest.

The school-to-school differences, in contrast, are quite large. Again using 1976 data, the ten most successful schools at attracting women averaged 18.4% FTUG women; the ten least successful schools (excluding military academies) averaged only 1.6% women. These contrasts are rather reliable over time: the 1976 "top ten" schools were well above the national average four years earlier, with 5.8% women in Fall, 1972; while the 1976 "bottom ten" schools averaged only 1.0% women in Fall 1972, well below the national average of 2.3%. This very wide difference, and the stability over time, leads us to ask: What differences between the successful and unsuccessful schools account for their differential success in attracting women? Some of the differences are relatively stable characteristics of the schools (size, location, reputation, etc.) which are not readily controllable by their administrators. Others include the range of women-oriented activities in which the school engages. Such activities are of central interest in formulating the recommendations in this report.

Two school characteristics account for a substantial part of the difference: larger schools have tended to do better than small ones, and academically or socially elite schools have outperformed less-elite schools. This is consistent with a "distinguished pioneer" mechanism, where the first wave of women entering engineering, an exceptionally gifted and geographically mobile group, were attracted to such schools. It is vital not to overemphasize these factors for, as we have noted, the enrollment of women in undergraduate engineering is growing rapidly. Consequently, suitable women students should increasingly be available to essentially all schools. What the school <u>does</u>, then, makes a difference in the number of women it attracts.

B. Underlying Mechanisms

> We do not favor the application of simple rules to complex situations, and do not support conformist solutions to diverse circumstances - complex situations require complex rules and diverse circumstances require diverse solutions.
>
> (Carnegie Commission on Higher Education: <u>Opportunities for Women in Higher Education</u>, 1973)

As a national phenomenon, the entry of women into engineering is clearly a "complex situation." It involves multiple forces - e.g., the growing career-consciousness of women, equal opportunity pressures on schools and employers, growing job opportunities in engineering and declining opportunities in fields such as teaching, and efforts made by engineering schools and professional societies. We do not address this complex of national forces. Our focus is specifically on the individual engineering undergraduate program, and the role of the college administration in facilitating entry of women.

Women-oriented programs take a variety of forms and emphases at different schools. However, their success or failure seems to be conditioned by the extent to which they address two key underlying mechanisms. We express these as hypotheses:

1. The Decision Support Hypothesis: Women considering engineering as an undergraduate major are doing something unusual. They are unsure about what the study or practice of the profession will involve; family, friends and teachers will generally have little helpful advice; there are few women engineers with whom to talk; and the situation is changing rapidly. In short, engineering is a "high uncertainty" choice for a woman, and relatively more reassurance or "decision support" is needed to reduce this uncertainty.

   The importance of support programs for women already in engineering school is documented by Davis, 1978, and others. We are here arguing for a more general hypothesis, that support is needed before entry as well as during undergraduate training. The nature of this support will vary over time and by situation. Prospective students can benefit from perception that they are welcome and will get a fair chance. New frosh need campus-oriented support; seniors, job-oriented reassurance.

2. The Positive Feedback Hypothesis: It appears that one of the most helpful factors in attracting women is to have a sizeable number already. This helps in various ways: social and academic support groups on campus, involving both peers and more advanced students (often referred to as having a "critical mass" of women students); establishing a grapevine for course and career guidance; "role models," both older students and women faculty; informal recruiting, through contact with current high school

students; attitude change, as high school and college faculty and counselors see women succeeding as engineering students; and so on.

Note that each mechanism implies possible traps for engineering college administrators. The Positive Feedback mechanism implies that "breaking in" is particularly difficult; and the Decision Support Hypothesis raises the danger that highly visible special programs for women may reinforce their perception of themselves as "unusual", with negative effects on recruitment and retention.

Situation-specific considerations are vital in interpreting the mechanisms at work. For instance, on one campus we were told that women came into engineering only after women were present in arts and sciences. At another, women perceived the relative absence of women in other fields as an advantage because they would not be subject to "unfair" social competition from women with easier course loads. These quite different situations make sense when considered in light of the two hypothesized mechanisms.

Decision Support and Positive Feedback mechanisms suggest positive actions to foster women in engineering efforts. The following are ideas that naturally require situation-specific review for their appropriateness:

a. Public recognition of performance by women students pays off.

b. Perceptions are all-important. Clustering women in class sections is one clever way to take advantage of reassurance in the presence of others (e.g., if one has 40 women in a frosh class of 2,000, place them all in one or two sections of introductory calculus of 100 students or so each - without making a point of it).

c. Determine the critical mass levels and strive to attain these. One level noted was about 3 women in each class (again, clustering may help attain such thresholds).

d. Interaction groups (such as SWE - Society of Women Engineers) may be most important when there are relatively few women present. They may also be a source of reassurance at critical points (e.g., new frosh, starting co-op students with their first harsh experiences on the job).

e. Recruitment may likewise cluster as a result of positive feedback at work. Recruits are likely to come from certain high schools, aided by positive reports from women who are succeeding in engineering.

The following more extensive action recommendations also derive from the assumption of these two underlying mechanisms.

C. Action Recommendations

1. Take Stock

Given the explosive growth in the numbers of women entering engineering in the past few years, criteria of success become rapidly obsolete. Several of the deans we spoke to expressed satisfaction with tiny representations of women in their programs. They seem to have set goals around 1970, when 1% or so women was the national average; with a current 2-3%, they feel they are doing rather well. In fact, of course, schools with less than 10% women in their entering classes are substantially lagging the national trend - and, given the positive feedback mechanisms, are likely to remain laggards. A first step then is to reassess how well one's school is doing in recruiting women. Schools with 15-20% women may be looking for a "growth maintenance" strategy. Those substantially below this level will, in our estimation, need an intensive focussed effort for a few years to "break in" on the positive feedback loop, and then move to a growth maintenance mode.

2. Actions Needed to Break In

Schools which find themselves substantially behind the national average in enrollments of women will need a period of hard work and serious commitment to break in. In part, this is implicit in the positive feedback mechanism sketched above; in part, low representation implies that the school may not have the facilitating characteristics (such as social or academic eliteness) noted earlier. The following elements appear important in mounting such an intensive effort:[1]

a. A careful assessment of present sources of students: In most cases, recruitment is primarily from high schools, but some engineering programs have significant recruitment from junior colleges, or of mature students. At least one program we contacted "broke in" by developing a special, intensive "second bachelors" program in engineering, recruiting women from liberal arts programs. Such careful identification of recruitment targets seems an important first step.

b. Intensive recruiting: In addition to general information-dissemination, our findings suggest that direct contact with potential students is crucial. Direct mail and personal contact with individual students seem effective; wide, thin recruiting (e.g. brochures) seems rather ineffective. Tactics used by successful programs include personal letters, telephone follow-up with prospective students, campus visits, and identifying one focal person on campus who can provide personal reassurance and help straighten out administrative hassles. Scholarships seem effective, even if the dollar value is modest, perhaps because of their reassurance value. High school visits are commonly used, particularly by schools which emphasize local recruitment (as against national recruitment). These seem most effective if they involve women engineers (faculty or current students), and if they provide an opportunity for personal discussions and good follow-on. In general, these efforts might be usefully viewed as career guidance - disseminating information on engineering as a career for the prospective student to make a better informed decision.

c. Review existing blocks: Despite recent gains, there remains evidence of specific pressures which close off engineering to women. Some high school career counselors may still be steering women away from engineering. Inadequate mathematical preparation in high schools remains a problem. Where such specific blocks are identified, focussed efforts at remediation may be highly effective.

d. Experiment: One of our clearest findings is that there is no "one best way" to boost enrollments of women. Successful programs are tailored to the particular school and its characteristics - the location, recruitment radius, program format, and

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[1]While we lack empirical support, the idea of giving someone direct responsibility to undertake a comprehensive women in engineering effort is intuitively appealing.

so on. While the experience of other schools can provide useful ideas[1], each school will have to experiment to find the most effective mix of activities for its situation.

e. Plan comprehensively: A successful women-oriented program requires attention to the entire sequence of activities from high school preparation to choice of undergraduate major and school, to college entry, to successful performance in school, and ultimately to job placement. A "crash program" in only one of these areas (e.g. high school recruiting) may fail if other parts of the sequence are ill-prepared (e.g. residential arrangements, campus support efforts). Positive feedback exacerbates the effects of such failures. Balanced attention to each part of the sequence is required in planning for the intensive effort.

In short, an intensive effort aimed at a rapid growth in enrollments of women will require a significant commitment, and at least some experimentation to determine the most effective mix of activities for a particular school. The sources of potential women students must be carefully identified, and a recruiting strategy formulated which stresses direct personal contact with the student. Particular blocks, especially in high school counseling and math preparation, may be identified and worked on. The general goal is to move within a few years to achieving a "critical mass" of women students. From there, the school can move to a "growth maintenance" mode.

3. Growth Maintenance

Our evidence suggests that, once a program has achieved a "critical mass" in terms of women enrolled, recruiting and retention efforts become somewhat self-sustaining, and require less intensive support from the school's administration. We are not, of course, advocating that women-oriented efforts be abandoned when enrollment reaches some pre-specified

[1] We will gladly provide references to those interested in what others are doing.

percentage; we are suggesting only that the intensive effort required for "breaking in" can be somewhat moderated when steady growth has been attained. Indeed, we cannot give any precise guidance as to when this point has been reached. Our statistical analyses do not clarify the point, and the deans with whom we spoke suggested several guidelines - "over 10-15%," "over a hundred total," "when there are several women in every class." Care is needed in deciding when this point has been reached in a particular program.

A "growth maintenance" mode requires attention to a number of specific matters, none individually critical, but of important cumulative effect. These include:

a. Maintain steady recruiting effort: As noted earlier, these efforts are greatly facilitated by having women currently in the program. Current students can be encouraged to undertake informal recruiting, on or off the campus, participate in high school visits, and so on.

b. Integrate women into campus life: Many, perhaps most, women engineering students seek equal treatment with male students, and are suspicious of obvious women-oriented activities. For example, several deans suggested that formal "Women in Engineering" offices tended to over-emphasize the special concern for women; their functions were better placed in existing facilities (such as the Dean of Students Office). Similarly, several deans noted that women students were suspicious of women-oriented organizations such as SWE, preferring to get involved in existing chapters of professional societies oriented to their disciplines. There appears to be a rather subtle balancing act here, meeting the special needs of women students without labelling them as outside the mainstream of engineering education.

c. Specific concerns: The physical facilities of engineering schools, designed for all-male student bodies, provide everything from minor irritants to major difficulties for women. Upgrading may be needed in housing, athletic and recreational facilities, lounges, and restrooms.

d. Support persons: Adequate counseling (academic, career, and personal) should be made available (for both men and women). Women faculty seem potentially important as "role models" for women students. However, there are presently so few that we cannot confirm how important they actually are.

e. Career facilitation: Women may, more than men, need help with choosing and planning their careers. In addition to career information and counseling, actual experience (in co-op programs and summer jobs) and contact with practicing women engineers seems helpful here. The next frontier in establishing the entire positive feedback chain will be successful job experience. Women need support at this stage too.

f. Retention: Reliable evidence on retention rates for men and women is hard to come by. What there is suggests considerable variation across schools. There are indications that women are less likely to drop out, and more likely to transfer, than are men, and to have overall slightly lower retention rates. In part, this is consistent with the broader academic interests found in women engineering students. Some programs experience substantial rates of transfer, both in and out, by women students. Since these processes seem so dependent on the particular circumstances (for example, the availability of other campus resources; the level of initial commitment to an engineering major), we can offer only general advice. First, the difference between men and women in retention rates is generally quite small and not of major concern. Second, it is not the retention rate itself but its underlying causes that matter. If women are leaving because of over-recruitment or a hostile atmosphere in engineering, there are grounds for concern; well-informed reassessment of career choices, on the other hand, seems entirely desirable.

Conclusion

The representation of women in engineering is growing rapidly, a change which is only partly attributable to the efforts of individual engineering schools. Percentage representation which was outstanding five years ago is now likely to be well behind the national average. Schools which are lagging in attracting these high-quality students may need a concentrated effort to catch up. Those which are now doing well should be able to sustain their growth by somewhat less-intensive attention to a number of specific matters, with fewer resources than are needed for a concentrated "break in" program. Indications are that the growth in percentage of women in undergraduate engineering programs will continue, and that high percentages of women will soon become the norm in engineering schools. We hope the proposals offered here will facilitate the achievement of this norm.

References

1. "The Recruitment and Retention of Women in Engineering: Final Report." Terry Connolly & Alan L. Porter. Available Fall 1978. (Presents the research and data on which the present Report is based.)

2. "Engineering and Technology Enrollments, Fall 1967 - Fall 1977." Published annually by the Engineering Manpower Commission of Engineers Joint Council, 345 East 47th St., New York 10017. (Reports detailed data on engineering enrollments by school, curriculum, year, race, sex, etc. for all U.S. engineering schools.)

3. "Female Engineering Students: Attitudes, Characteristics, Responses to Engineering Education." Mary D. Ott, College of Engineering, Cornell University. (Final Report on a large N.S.F.-sponsored project; provides careful documentation of a nation-wide sample of men and women engineering students.)

4. "Beyond Tokenism." Sandra O. Davis. New Engineer, Feb., 1978, pp. 22-29. (Gives an interesting, "in-their-own-words" picture of men and women engineering students; documents the need for support programs.)

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THE RECRUITMENT AND RETENTION OF WOMEN
AS UNDERGRADUATE ENGINEERS

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Drastic changes are presently taking place with respect to the enrollment of women in undergraduate engineering programs. As recently as 1970, the 3569 full-time undergraduate women in engineering (WiE) represented only 1.5% of the total engineering student population; as of 1977, the 28,773 WiE constituted 10% of the population.[1] The "why's and wherefore's" of this phenomenon comprise the focus of this study. Our basic tenet is that attracting women into engineering is desirable, both for the nation as a whole and for individual schools. It is thus important to understand what factors support the recruitment and retention of women in undergraduate engineering programs.

As a national phenomenon, the entry of women into engineering is clearly a complex process. It involves multiple forces - e.g., the growing career-consciousness of women, equal opportunity pressures on schools and employers, growing job opportunities in engineering and declining opportunities in fields such as teaching, and efforts made by engineering schools and professional societies. We do not address this complex of national forces. Our focus is specifically on the individual engineering undergraduate program, and the role of the college administration in facilitating entry of women.

Women-oriented programs take a variety of forms and emphases at different schools. However, their success or failure seems to be conditioned by the extent to which they address two key underlying mechanisms. We express these as hypotheses:

1. <u>The Decision Support Hypothesis</u>: Women considering engineering as an undergraduate major are doing something unusual. They are unsure about what the study or practice of the profession will involve; family, friends and teachers will generally have little helpful advice; there are few women engineers with whom to talk; and the situation is changing rapidly. In short, engineering is a "high uncertainty" choice for a woman, and relatively more reassurance or "decision support" is needed to reduce this uncertainty.

   The importance of support programs for women already in engineering school is documented by Davis[2]. We are here arguing for a more general hypothesis, that support is needed before entry as well as during undergraduate training. The nature of this support will vary over time and by situation. Prospective students can benefit from the perception that they are welcome and will get a fair chance. New frosh need campus-oriented support; seniors, job-oriented reassurance.

2. The Positive Feedback Hypothesis: It appears that one of the most helpful factors in attracting women is to have a sizeable number already. This helps in various ways: social and academic support groups on campus, involving both peers and more advanced students (often referred to as having a "critical mass" of women students); establishing a grapevine for course and career guidance; "role models," both older students and women faculty; informal recruiting, through contact with current high school students; attitude change, as high school and college faculty and counselors see women succeeding as engineering students; and so on.

Against the backdrop of these two hypotheses, this paper explores a series of explicit questions concerning the recruitment and retention of WiE. The following section sets out the sources of information upon which the analysis draws. Following the series of questions, we offer several recommendations directed toward the school interested in furthering its enrollment of WiE.

STUDY DESIGN

To get a broad perspective on the issues associated with the attraction of women to undergraduate engineering education, we designed a three-part study:

1. A cross-sectional survey of all U.S. engineering schools. Basic demographic information was obtained for 289 U.S. engineering schools from the Engineers Joint Council (EJC) for the years

1972, 1976 and 1977.[3] Information on WiE efforts was taken from an ASEE survey of such programs.[4]

2. A focussed study of 60 "extreme case" engineering schools. From the 1976 EJC data, we divided schools on the basis of total engineering enrollments into three categories: "Small" schools (100-500 Full-Time Undergraduate (FTUG) students in engineering); "Medium" schools (500-1500 FTUG); and "Large" schools (over 1500 FTUG). (Military academies and other special-purpose schools were eliminated from the analysis.) From each category, we selected the ten schools with the highest, and the ten with the lowest, percentage of WiE, for a total of 60 "extreme cases." The 60 schools are listed in Table 1. For each school, we compiled extensive background information from various sources (e.g. Barron's Guide, school catalogs), which (for 54 of the schools) we were able to check and supplement from the schools themselves. Telephone interviews were conducted in Spring 1978 with deans of engineering and other officials at 59 of the schools. We used a focussed interview approach, working from a carefully-structured interview guide while also allowing the conversation to follow the interviewee's interests. The records of these interviews were independently coded by the authors. After resolution of coding differences, this generated 15 coded variables which were keypunched and added to the background data. Numerous insights and anecdotes were also garnered from these interviews.

3. An in-depth study of one school (Georgia Tech) with a successful WiE program. Our information here came from a number of sources. A mail questionnaire was sent to all entering frosh women in

engineering and a sample of frosh men in Fall, 1977. This tapped the students' backgrounds, reasons for selecting Georgia Tech, their expectations about life at Tech, and attitudes on a number of issues (including, especially, their attitudes toward women in engineering). A second questionnaire was mailed in Spring, 1978, requesting essentially the same information as the students neared completion of their first year. (The initial mailing was to 215 men and 179 women. 160 men and 155 women responded. The Spring mailing to these respondents yielded 120 and 102 responses, respectively, an overall response rate of 57% for women and 56% for men. All analyses are based on those who responded to both questionnaires.) The questionnaire information was supplemented by open-ended telephone interviews with 15 frosh and 15 senior women engineering students. Finally, personal interviews were held with various administrative, counseling, advisory and placement people at Tech, to build up a picture of what WiE activities were going on, and how well the participants saw them as working.

WHAT IS THE GENERAL SITUATION TODAY WITH RESPECT TO WOMEN IN ENGINEERING (WiE)?

Historically, the engineering profession has attracted only tiny numbers of women. As recently as 1970, only about 1% of undergraduate engineering degrees awarded in this country went to women. However, since the early 1970's, this situation has been changing very rapidly (Figure 1). As of Fall 1977, women represented 10% of full-time undergraduate (FTUG) engineering students, and over 11% of the entering class.[1] Assuming this trend continues, we project about 54,000 women, roughly 14% of all FTUG engineering students in the U.S., by Fall 1980.

This gain has not been one of numbers alone. The women now entering undergraduate engineering programs have been academically very able, typically as strong as, or stronger than, their male counterparts. Mary Ott,[5] reviewing a range of indicators of academic ability, concluded that "women engineering students are among the best qualified students at U.S. universities," a conclusion echoed by our own data. Further, there are indications that these women often tend toward positions of campus leadership in student government, professional honorary societies, and so on. (It should be borne in mind, of course, that these outstanding women students represent the "pioneers." There are indications that, as engineering becomes a truly open option for women, the ability distribution of women engineering students becomes similar to that for men - a healthy normalization process, in our view.)

The movement of women into engineering has not been confined to one or two areas of the country. It has, rather, been a broadly-distributed national phenomenon. For example, the Fall, 1976 national average was 8.5% women. Only four states (Maine, 4.6%; South Carolina, 4.9%; Nebraska, 4.9%; and Utah, 4.8%) fell below 5% women in their engineering schools; and only eight states exceeded 10% (Delaware, 11.4%; Pennsylvania, 10.8%; Michigan, 10.5%; Georgia, 10.4%; Tennessee, 10.8%; Missouri, 10.6%; Montana, 10.6%; and Nevada, 10.4%). The trend, then, is geographically widespread; and state-to-state variance is modest.

The school-to-school differences, in contrast, are quite large. Again using 1976 data, the ten most successful schools at attracting women averaged 18.4% women; the ten least successful schools (excluding military academies) averaged only 1.6% women! These contrasts are rather reliable over time: the 1976 "top ten" schools were well above the national average four years earlier, with 5.8% women in Fall, 1972; while the 1976 "bottom ten" schools averaged only 1.0% women in Fall, 1972, well below the national average of 2.3%. Indeed, the strongest predictor of WiE at a given campus is the number they have attracted in the past. For example in considering the 60 "extreme case" schools, the percentage of Frosh WiE for 1976 correlates 0.57 with the percentage of Frosh WiE for 1972 and 0.85 with the percentage of all undergraduate WiE for 1976. This strongly supports the "Positive Feedback Hypothesis" proposed earlier.

The very wide differences among schools in WiE enrollments, and the stability of these differences over time, leads us to ask: What differences between the successful and unsuccessful schools account for their differential success in attracting women? Some of the differences are relatively stable characteristics of the schools (size, location, reputation, etc.) which are not readily controllable by their administrators. Others include the range of women-oriented activities in which the school engages. Such activities are of central interest in formulating the recommendations in this study. We now look at a number of these differences among schools, moving from the relatively stable factors to those more amenable to policy control.

HOW DO LARGE AND SMALL SCHOOLS COMPARE?

Figure 2 presents data for all engineering schools according to size and four measures of WiE. A reasonable interpretation can be made by first considering that % Frosh WiE is a leading indicator of % total undergraduate WiE a few years later. What we then see is that all sizes of engineering schools were averaging some 2.5%* full-time undergraduate WiE in 1972. The medium size schools then led the way in the growing proportions of WiE from 1972-1976 (note this in terms of both % Frosh WiE for 1972 and % total undergraduate WiE in 1976). However, it now appears that the large schools are taking over the leadership position (note % Frosh for 1976) and will, in coming years, show the largest overall % WiE.** However, this should be seen in perspective that all size schools are showing a continuing increase in % WiE.

A related possibility of interest is the comparison of four-year colleges with universities offering graduate degrees. We tabulated those schools with no graduate students versus those with one or more graduate students as a rough index of these. The results indicate non-significant differences favoring WiE in universities. For instance, % Frosh WiE for 1976 averaged 8.7% for 73 "colleges," and 9.9% for 202 "universities." Alternative interpretations of this observed small difference appear more

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*Our unit of analysis is the school, so that a % WiE for some type of school represents the average % WiE for such schools, not the overall average computed by taking all the WiE in such schools divided by the total undergraduates in those schools (i.e., it is the average of the %'s at each of the schools in a given category).

**Statistically, Analysis of Variance shows significant differences among the four sizes of schools for the three measures other than % WiE, 1972. By t test (not the conservative choice), the differences between medium and large schools are significant for 1972 Frosh WiE, but not for 1976 % WiE or % Frosh WiE. The 1976 measures do show a significant difference between medium and small size schools.

probable - namely, that women are somewhat more attracted to large and high quality schools, which the universities tend to be.

DOES SCHOOL QUALITY MAKE A DIFFERENCE IN THE PERCENTAGE OF WiE STUDENTS?

On first glance, one might imagine that women students would apportion themselves about the same way as men across schools of different academic quality. However, recalling that WiE students (especially the "pioneers" of the early 1970's) tended to be superior students, one might imagine that they gravitated to the superior schools. That is indeed the case. For our 60 "extreme case" schools, two different measures of "quality" show that women have significantly favored the better schools:

	*Admission Standards (SAT-Math Equivalent)	Average Rating by Accreditors (1 = Poor; 5 = Excellent)
High % WiE Schools	599	3.2
Low % WiE Schools	521	2.5

Another important feature to note is that the higher "quality" schools tend to be larger size schools (size correlates 0.64 with the accreditors'

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*Three engineering educators with extensive accreditation experience rated the overall quality of the undergraduate engineering programs at each school on a five-point scale from "poor" to "excellent." The three ratings are averaged here. For 54 of the schools, we were also able to estimate an SAT-Math equivalent score for the whole college, using a regression equation to convert ACT scores or SAT scores for engineering students only to estimated SAT-Math scores for the college as a whole where the latter was not directly available. The two "quality" measures correlate .60.

average ratings; 0.20 with the SAT score equivalent). Thus, the influences of size and quality as influences in attracting WiE are somewhat confounded. To help sort out these factors, many of the following data displays present separate, parallel analyses by size and by quality (based on mean SAT-Math equivalent score).

Two school characteristics that appear closely related to school quality are student mobility and full-time status. Students who attend college outside their home state are likely to be better students, attending better colleges. It is striking that for those of our "extreme case" schools reporting, some 60.5% of the women were out-of-state (N = 34 schools) versus only 37.5% of the total engineering student body (N = 41). Drawing upon the broader base of all engineering schools , it was possible to classify schools as below or above average in part-time engineering enrollment percentage. What we found was that schools with smaller part-time enrollments had higher % WiE. For instance, the 1976 % Frosh WiE averaged 10.3% for below-average-part-time schools (N = 206) vs. 7.7% for above-average ones (N = 69). Part-time enrollment percentage is an apparent correlate with a local catchment area, as well as with quality. Thus, the picture that emerges is that women have leaned toward higher "quality" schools, often out-of-state, and on a full-time basis. However, it is important to consider also that the WiE are seemingly coming in greater numbers, and are of more normal aptitudes, implying that more and more will be interested in the less elite schools.

The features just discussed (i.e., size, quality, etc.) are relatively permanent characteristics of a school. We now turn to factors that are more flexibly under the control of school administrators and that may also have something to do with the recruitment and retention of WiE.

WHAT ARE TYPICAL WiE-ORIENTED EFFORTS?

Our best source of information in response to this question is a 1976 ASEE survey.[4] That report provides a brief summary of WiE-oriented activities at some 115 schools; we analyze the 108 that also appear in the 1976 Engineers Joint Council report.[3] While the intent of the ASEE survey is to include all schools with active WiE programs, the comprehensiveness and accuracy of these data must be considered with some reservations. Of particular interest to us, the ASEE directory lists eight relatively common activities, as tabulated in Table 2. As indicated therein, the presence of a Society of Women Engineers (SWE) or similar organization is most commonly mentioned - 88% of the 108 ASEE directory schools so note, or 35% of the total 275 engineering schools. Some 24% of all engineering schools have been involved in preparation of publications about WiE at their institution, have offered women-oriented financial aid, or have recruiting efforts involving high school counselors. Somewhat less common are summer or school-year conferences or programs for high school women. Even less common are special programs for junior high school women (and also graduate fellowship programs - 31 schools - not of direct interest here, since we focus on undergraduate education).

Further analysis shows a clear tendency for universities to be more active than smaller schools, and for large schools to be more active than smaller schools. For example, SWE or a similar organization is reported by 95 schools, 35% of the total 275. Only 14% of the four-year colleges, versus 42% of the universities, report such an organization; only 2 "Very Small" schools (6%), 7 "Small" schools (8%), 47 "Medium" schools (45%), and fully 39 "Large" schools (78%) report having such organizations. In short, the probability of finding any given WiE-oriented program activity increases sharply as one moves from small to large schools of engineering - the correlation between size and presence of each of the seven activities ranges from 0.24 to 0.56.

It should be noted that the chance of inclusion in the Directory increases very sharply with size of school. Less than 10% of the very small schools, and only about 14% of the small schools, appear. In contrast, over 50% of the medium-sized schools, and fully 80% of the large schools, appear. It seems entirely likely that the heavy representation of large schools is a result both of their higher probability of having active WiE programs, and of them being relatively more visible than small schools.

Further, there are positive correlations between the measures of program activities themselves, implying that schools with one such activity are more likely to have another. Correlations among the seven activities range from 0.31 to 0.72, averaging 0.51.* Again, the relationship of each activity with size of school appears to contribute to this linkage (the correlations decrease when size is controlled). For our purposes, the important implication is that these program activities are not independent of one another; they are, in most cases, quite strongly clustered together, with schools which have one being quite likely to have others.

DO SUCH WiE-ORIENTED PROGRAM ACTIVITIES ATTRACT WOMEN STUDENTS?

The crucial issue in this analysis is, of course, whether or not these

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*The survey procedure of inquiring about these activities at the same time would be conducive to inflating the apparent relationships in that respondents might tend to respond positively, or negatively, to a whole series of the items.

women-oriented activities "work," in the sense of being associated with larger proportions of women in schools which support such program activities. Table 3 presents two complementary sorts of information that bear upon this question. Based upon the ASEE survey , tallies are presented showing the percentages of total WiE and Frosh WiE for 1976 according to the presence or absence of each of the seven activities. In general, the presence of any particular activity seems to yield only a marginal advantage in % WiE. The correlations between each activity and % total WiE or % Frosh WiE suggest a similar interpretation. The correlations tend to be positive, but small. When one controls for the size of school, the correlations, especially with % Frosh WiE, are substantially reduced.* This is consistent with the previous observation that large schools tend to engage in more women-oriented program activities. Recalling the WiE pattern by school size in which medium schools seem to have led the way until just recently, it also appears that inclusion in the ASEE survey relates to more Frosh WiE chiefly for the larger schools.

Table 3 suggests, overall, that WiE activities have some small effect. Inclusion in the ASEE directory is a better predictor of % total WiE than any single activity. Of the individual activities, the presence of a Society of Women Engineers (SWE) chapter or similar organization appears most clearly related to % WiE. The interpretation of such a finding is, however,

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*ANOVAs were computed for each of the recruiting activities by size of school. These were done for each of 3 categorizations: 1) schools not listed (N/L) in the ASEE directory kept separate, 2) N/L combined with "No," 3) N/L excluded. In no case, for any recruiting activity, was there a significant interaction with size. The recruiting variables tended to be significant ($p < .05$) for % Women, but for % Frosh size overwhelmed their influence.

rather difficult. The number of non-SWE schools is quite small ($\underline{N}$ = 13). Further, the measurement itself is likely to be quite poor for most of these activities (i.e., positive response bias, lack of clear-cut definitions of what constitutes the activity). Poor measurement is likely to understate the efficacy of the program activities. On the other hand, the activities themselves are quite correlated with other school features such as size, which in their own right correlate with WiE. Hence, cause and effect determinations are on rather weak footing. For instance, it is quite plausible that a SWE chapter develops when there are substantial numbers of women on campus (more likely at a large school). Yet, that SWE chapter may turn around and contribute to further recruitment efforts (via our decision support and positive feedback mechanisms). So, all-in-all, the picture shows no strong support for any particular women-oriented program activity, but some support for women-oriented activities in general.

Turning to the 60 "extreme case" schools, we can add some additional insight to the workings of WiE-oriented activities. We posed a somewhat different set of questions to schools selected for their relative success or failure in attracting WiE, and attempted to separate out the effects of school size and quality in the analyses. Table 4 provides a scale score for the overall level of WiE recruiting effort (based on the phone interviews). Several observations stand out:

- recruiting efforts for WiE are related to size of school - larger schools do more than smaller ones;
- success in attracting WiE is moderately related to effort expended, especially for large schools;
- recruiting efforts are not related to school "quality";
- however, WiE recruiting is sharply higher for low score schools

that have attracted women than for any other category.

Tables 5 and 6 present information on two specific program activities - direct mailings to prospective WiE students, and opportunity for direct personal contact with such students. The direct mailing data suggest that this is a preferred recruiting strategy for schools with successful WiE efforts, much less so for unsuccessful schools. This pattern is quite marked except for large schools, where several of the unsuccessful schools use this approach. The direct personal contact measure tapped the extent of opportunities for students to visit campus, talk to school representatives at length, and so on. This appears to relate to WiE success for certain schools, namely:

- large schools successful in attracting WiE; and
- schools of less imposing academic scores successful in attracting WiE.

For such schools, it appears that personal contact may be an important element in the WiE recruiting strategy, again supporting our "Decision Support" Hypothesis.

Similar analyses on a number of other WiE program activities can be summarized as follows:

- Special financial aid for women related to WiE success much as did direct personal contact opportunity - that is, it appears effective mainly for large schools and for those with lower academic scores.
- High school contacts and WiE brochures did not evidence any sharp distinctions; they were reported about as much by unsuccessful as by successful schools.

In summary, the results indicate some support for WiE-oriented programs. While no single program activity appears to be the perfect answer, opportunities for personal contact in various forms appear important. Direct mail contacts are quite sensible when one considers highly mobile, superior women students considering schools nationally. Naturally, not all schools recruit from such a national catchment area. For these schools, other routes that facilitate "decision support" make considerable sense. Even the presence of a SWE chapter can be interpreted in these terms of opportunity for personal interaction. Analysis of the ASEE data yielded another interesting finding. A rough measure of total school WiE effort could be obtained by a count of how many activities were reported by a school. The results indicated that schools reporting a moderate number of these activities (3-5) had more WiE than either schools reporting very few such actions (i.e., 0 or 1) or schools reporting most all of the eight items (i.e., 6 to 8). While there is some indication of reporting distortions (i.e., that schools not really doing much responded affirmatively to most everything), this may also indicate that too much attention may be self-defeating. This could be seen as a "labelling" phenomenon in which women are not attracted because the emphasis given them in the school labels them as "deviant" or "in need of special help."

ALL-IN-ALL, WHAT MAKES A DIFFERENCE IN ATTRACTING WiE?

We now broaden the question to ask what does relate to the observed differences in WiE at various schools across the U.S. Differences may be attributed to situational factors, school characteristics, or program activities. We have already discussed the lack of strong regional distinctions across the country and the presence of a very strong time factor - WiE enrollments are accelerating on a broad front. Local situational factors may also be important, for instance:

- Limits on out-of-state students may deter WiE, given their greater tendency to go to school in other states.
- Lack of women's housing may be especially important. (In our 60 extreme case sample, 62% of the women students were housed on campus (N = 37 schools) vs. 56% of all students (N = 54)).
- Catchment characteristics may deter high women enrollments. (e.g., conservative farm communities, traditional religious emphasis).
- Special conditions may be critical. (e.g., the military academies.)

Basic school characteristics stand out as important determinants of attractiveness to WiE. Quality, in terms of student caliber or reputation, has been noted as a strong correlate of success in attracting WiE. Attractiveness of campus, of location, and of programs offered (e.g., environmental engineering over traditional mechanical engineering) can influence a woman's choice of a school. Presence of women faculty may be a secondary factor (a support) for WiE. (It is striking that only about 2% of the engineering faculty at our 60 school sample were women. This translates into zero women faculty at most of the small and medium engineering schools!)

To probe the interactions among these various influences on WiE program success, a series of stepwise multiple regressions was computed for the 60 "extreme case" school sample. Various combinations of independent variables were studied, using either total % WiE or % Frosh WiE (Fall 1976) as dependent variables. The analyses converged on the following conclusions:

1. The best predictor of 1976 % WiE (either total or Frosh) was % WiE Frosh in Fall 1972 (or, alternatively, total % WiE in Fall 1972).
2. The next predictor was a measure of the "quality" of the school, usually our estimate of SAT-Math score, with average rated

quality entering some analyses.

3. The variable indicating whether or not direct mailings to prospective students were used typically entered the regression equation as a positive predictor of WiE program success (by either of our measures). This is rather strong support for the value of this approach, since the variable enters the equations even after school "quality" is controlled.

4. Several other independent variables entered the regressions, although not to the extent of the first three:
   - the variable indicating the presence of a designated person responsible for WiE efforts is positively related to both measures of WiE program success;
   - the % women housed on campus is positively related to program success;
   - School size is <u>negatively</u> related to program success;
   - the availability of a brochure concerned with WiE is <u>negatively</u> related to program success.

Other school characteristics (such as % students from in-state, expenses, and % women faculty), while apparently associated with program success when considered alone (i.e. are positively correlated with success) are outweighed by these variables. That is, they appear to be subsumed by our measure of school "quality," and did not enter the regressions once "quality" measures had been included. (Note that these relationships describe <u>residual</u> correlation after previous variables have been taken into account. That is, after "partialling out" the effects of 1972 enrollments, school quality, and use of direct mailings, the relationships noted above appear. The relatively small sample size and the likely imperfections of the measures should add a note of caution to the interpretation of these regression results.)

It does appear, however, that many of the factors associated with success of a WiE program are largely uncontrollable by the individual school, at least in the short term. Reports of Frosh attending one school, Georgia Tech, further indicate the importance of the non-controllable influences. As indicated in Table 7, women chose Georgia Tech based more on its characteristics than upon recruiting efforts. Of those recruiting efforts, financial aid and direct contact show up as significantly more influential for women than for men. This response should be viewed in the context of the effort made by Georgia Tech to attract WiE.

The WiE efforts at Tech essentially began at the initiative of one individual (Associate Dean) in the late 1960's. With the efforts of a dynamic assistant, an active recruitment effort was begun. It has since tapered off to some degree. This program is informal, involving subtle special handling for women. The more important recruiting efforts are those entailing some form of individual contact, primarily via the mail. Special letters to women applicants to Tech; follow-up letters after acceptance, before admission; and provision of a contact person (themselves) are seen as most effective. Direct national mailings, high school contacts, special WiE brochures, and special alerting to scholarship opportunities are also done. In the past a fair number (35) of scholarships for women have been available. These offered small amounts (i.e., on the order of $250/year) but considerable visibility. The number available is decreasing dramatically; there may be none next year due to a decline in industrial support for women in engineering efforts. The WiE effort here might be characterized as low key "special handling." It is perceived as effective by the administrators involved.

HOW DO MEN AND WOMEN ENGINEERING STUDENTS DIFFER?

The previous discussion has focussed on the recruitment of WiE. In so doing, various considerations of more significance to women than to men have been raised. We now pursue this inquiry into characteristic differences in the belief that this may point to needed support activities vis-a-vis retention as well as recruitment of WiE.

To begin, we reemphasize that women are at least as good engineering students as men. In replies to our interviews with the "extreme case" schools:

- only 1 school found men better than women on admission records, vs. 20 that reported women were better, and 20 reporting there was no difference;
- only 2 schools reported that men's grade point averages in college were better, vs. 32 finding women were better, and 12 seeing no difference;
- only 7 schools believed women dropped out at a higher rate, vs. 20 reporting that their rate was lower, and 21 no difference.

The image is that WiE are desirable students.*

Our survey of Georgia Tech Frosh probes further to suggest differences among men and women engineering students. Table 8 highlights some of the differences. For these students, financial aid was a more important inducement for women than for men in coming to Tech. The entering women were less clear on the choice of a major field. They also tended to be less

*(Few schools were able to supply numerical "hard data" on these variables. In most cases, we are relying on the opinions of the relevant officials; "no opinion" responses make up the balance of the 60-school total.)

sure of their ability to perform well academically and more concerned about good performance. (This is striking given that Tech WiE are no exception to the general status of being equal or better students than their male counterparts.) Looking further in the future, Tech WiE are slightly less certain of their choice of school (Tech is predominantly an engineering school), plans to gain co-op work experience, or to go on to graduate school in engineering. All of these men-women differences get larger by the latter part of their Frosh year (all except the graduate school item become significantly different). Women also value various forms of counseling more highly than do men. This is consistent with their apparently greater uncertainties (also, with our initial decision support hypothesis). Socially, women are more oriented toward friendship relations and, by June, are significantly more confident of success in making friends and studying with others. As suggested in these findings and demonstrated in a large cross-campus study by Mary Ott,[5] WiE have broader cultural and recreational interests than do men. Further, WiE are activists, according to interview anecdotes, at least. They tend to become involved in student professional society chapters (often as officers) and a wide range of campus activities.

Drawing these findings (primarily based on Georgia Tech) together suggests that women enter college less sure of their abilities, but committed to doing well. In fact, they do as well as, or better than, men academically, and have a broader social experience. After a year at Tech, women are as satisfied as men with their work, see themselves as doing as well, and having a better time as well. However, they are more likely than men to be wondering whether they are at the right school, in the right field.

Table 8 and the remainder of the questionnaire findings not presented therein strongly suggest, despite the previous paragraphs, that men and women in engineering are more similar than different.[6] Note that even the significant differences on particular items tend to be small. This image of similarity is further strengthened by comments of Tech Frosh and seniors in open-ended interviews. When asked what they saw as particular needs at Tech, they indicated:

- no special treatment - 9 mentions (of 30 interviews)
- lighter study demands - 6 "
- better housing facilities - 5 "
- better counselling support - 2 "

Comments by Tech staff further indicate that women even use much the same pressure releases as men - e.g., beer drinking, and use of recreational athletic facilities.

WHAT [illegible] ARE THE IMPLICATIONS FOR VARIOUS WiE SUPPORT ACTIVITIES?

[illegible]eresting result from the survey of Georgia Tech Frosh was a si[illegible] difference between men and women in their feelings toward WiE. On a positively directed 1 to 5 scale, women averaged 4.5 over a series of 21 items; men, 3.8. It should be emphasized that the men are not anti-women-engineers, rather than are not as strongly positive. This suggests a possible source of support for WiE in other WiE. That is consistent with our positive feedback hypothesis - that one of the most helpful factors for WiE is to have a sizeable number already. Previously discussed statistical results also support this idea (e.g., the best predictor of WiE is previous WiE).

Another basic observation is that special WiE efforts should probably not be highly visible. Women are sensitive to their minority status in engineering (although their problems are quite unlike those of ethnic minority students). They do not generally wish to be singled out for special treatment, as previously discussed items have suggested.

A particular instance seems to reflect both of these principles at work. The presence of a SWE chapter on campus relates to a higher percentage of WiE. A SWE chapter can serve important needs in providing interaction with other women, role models, and counsel at critical junctures (e.g., as a new Frosh, first co-op job experiences, or going on the job market via interviews). Ironically, a SWE chapter may be most important when there are relatively few women present. Yet, there is not uniform support by WiE for SWE participation. Several of the 60 "extreme case" schools noted that their WiE had not supported the formation of a SWE chapter. Our phone interviews with Frosh and senior Tech WiE found that only 14% had joined SWE.

Table 9 presents a tally of responses of the 60 "extreme case" schools to four questions directed at the extent of direct WiE support efforts. The first observation is that such efforts tend to be fairly limited - not many schools are doing very much. In looking further at the breakdowns by size and "quality" of school, it appears that WiE support activities are associated with higher WiE percentages for medium and large schools, but not for small schools (basically, few of which are doing anything). High "quality" schools with high WiE %'s are doing distinctly more than such schools with low % WiE. The results suggest that support efforts are largely taking place at just those schools which tend to attract more WiE anyway.

RECOMMENDATIONS

In thinking of individual schools, one might first focus on recruiting. School selection seems to depend more on basic school characteristics than upon specific recruiting. Social attitudes appear generally supportive of WiE. Yet, there still seems a worthy role in getting out information on engineering early in high school careers to prospective WiE's. More will be said on such "recruiting" activities shortly.

Whatever else is said, the recruiting and retention of WiE is highly situation dependent. Any policies should take into account a school's specific objectives and characteristics. For instance, Georgia Tech presents a situation where women are a minority, but engineers are a majority. That eases pressures on WiE. Further, Tech has an advantage in retaining WiE because of limited transfer opportunities on campus (and some social pressures against such transfer). Some Tech WiE noted that the heavy engineering focus of the campus is helpful, in that they don't have to compete socially with other women students with easier academic loads in general. Successful WiE programs must take account of such situation-specific, local factors.

Were we to direct specific recommendations to those establishing short-term policy at particular engineering schools, we would suggest an important dichotomy. Given the positive feedback mechanism, it is important to distinguish between schools which now have sizeable WiE representations and those which do not. Schools with, say, 15-20% WiE may be looking to an enrollment "growth maintenance" strategy. Those substantially below this level will, in our estimation, need an intensive focussed effort for a few years to "break in" on the positive feedback loop, and then move to a growth maintenance mode. Thus, administrators should begin by taking stock as to which mode describes their situation.

For those schools needing to "break in," the following elements appear important:

a. A careful assessment of present sources of students: In most cases, recruitment is primarily from high schools, but some engineering programs have significant recruitment from junior colleges, or of mature students. At least one program we contacted "broke in" by developing a special, intensive "second bachelors" program in engineering, recruiting women from liberal arts programs.

b. Intensive recruiting: In addition to general information-dissemination, our findings suggest that direct contact with potential students is crucial. Direct mail and personal contact with individual students seem effective; wide, thin recruiting (e.g. brochures) seems rather ineffective. Tactics used by successful programs include personal letters, telephone follow-up with prospective students, campus visits, and identifying one focal person on campus who can provide personal reassurance and help straighten out administrative hassles. Scholarships seem effective, even if the dollar value is modest, perhaps because of their reassurance value. High school visits are commonly used, particularly by schools which emphasize local (as against national) recruitment. These visits seem most effective if they involve women engineers (faculty or current students), and if they provide an opportunity for personal discussions and good follow-on.

c. Review existing blocks: Despite recent gains, there remains evidence of specific pressures which close off engineering to women. Some high school career counselors may still be steering women away from engineering. Inadequate mathematical preparation in high schools remains a problem. Where such specific blocks are identified, focussed efforts at remediation may be highly effective.

d. Experiment: One of our clearest findings is that there is no "one best way" to boost enrollments of women. Successful programs are tailored to the particular school and its characteristics - the location, recruitment radius, program format, and so on.

e. Plan comprehensively: A successful women-oriented program requires attention to the entire sequence of activities from high school preparation to choice of undergraduate major and school, to college entry, to successful performance in school, and ultimately to job placement. A "crash program" in only one of these areas (e.g. high school recruiting) may fail if other parts of the sequence are ill-prepared (e.g. residential arrangements, campus support efforts). Positive feedback exacerbates the effects of such failures.

For schools in the "growth maintenance" category, our evidence suggests that recruiting and retention efforts become somewhat self-sustaining, and require less intensive support from the school's administration. We are not advocating that women-oriented efforts be abandoned when enrollment reaches some pre-specified percentage; we are suggesting only that the intensive effort required for "breaking in" can be somewhat moderated when steady growth has been attained. Indeed, we cannot give any precise guidance as to when this point has been reached. Our statistical analyses do not clarify the point, and the deans with whom we spoke suggested several guidelines - "over 10-15%," "over a hundred total," "when there are several women in every class." Care is needed in deciding when this point has been reached in a particular program.

A "growth maintenance" mode requires attention to a number of specific matters, none individually critical, but of important cumulative effect. These include:

a. Maintain steady recruiting effort: As noted earlier, these efforts are greatly facilitated by having women currently in the program. Current students can be encouraged to undertake informal recruiting, on or off the campus, participate in high school visits, and so on.

b. Integrate women into campus life: Many, perhaps most, women engineering students seek equal treatment with male students, and are suspicious of obvious women-oriented activities. For example, several deans suggested that formal "Women in Engineering" offices tended to over-emphasize the special concern for women; their functions were better placed in existing facilities (such as the Dean of Students Office). Similarly, several deans noted that women students were suspicious of women-oriented organizations such as SWE, preferring to get involved in existing chapters of professional societies oriented to their disciplines. There appears to be a rather subtle balancing act here, meeting the special needs of women students without labelling them as "deviants."

c. Specific concerns: The physical facilities of engineering schools, designed for all-male student bodies, provide everything from minor irritants to major difficulties for women. Upgrading may be needed in housing, athletic and recreational facilities, lounges, and restrooms.

d. Support persons: Adequate counseling (academic, career, and personal) should be made available (for both men and women). Women faculty seem potentially important as "role models" for women students. However, there are presently so few that we cannot confirm how important they actually are. Women students may be each other's most valuable support people, and such support can be facilitated by the school (e.g. if there are only 40 women in a Frosh class of 2,000, discretely assigning the women into one or two sections of introductory calculus would facilitate them getting to know one another, and thus provide personal as well as academic support).

e. Career facilitation: Women may, more than men, need help with choosing and planning their careers. In addition to career information and counseling, actual experience (in co-op programs and summer jobs) and contact with practicing women engineers seems helpful here. The next frontier in establishing the entire positive feedback chain will be successful job experience. Women need support at this stage too.

f. Retention: Reliable evidence on retention rates for men and women is hard to come by. What there is suggests considerable variation across schools. There are indications that women are less likely to drop out, and more likely to transfer, than are men, and to have overall slightly lower retention rates. In part, this is consistent with the broader academic interests found in women engineering students. Some programs experience substantial rates be needed in housing, athletic and recreational facilities, lounges, and restrooms.

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We should caution that this study has been oriented to the WiE situations at individual schools. It has not directly addressed the national situation, other than to point out the national boom in WiE enrollments. Thus on these data, we cannot assess the extent to which the cumulative effect of WiE efforts at engineering schools overall has contributed to this national trend. We can mention a few pertinent factors worthy of consideration on a national basis. Above all, there are some disquieting signals that the WiE boom could be leveling. Data indicate continued growth in % Frosh WiE's, but a slowing rate of growth for the past two years (Figure 1). The positive feedback loop still requires confirmation of the positive overall job experiences of the pioneer WiE. This is needed to support future women students in choosing engineering and to encourage industry to continue its drive to recruit WiE. As companies meet Federal equal opportunity requirements (set quite low because of the historically low percentage of women in engineering), they may slacken their efforts. There are already indications of a drying up of corporate scholarship support for WiE. This is thus no time to rest on laurels, but instead a time for careful stock-taking and carefully directed efforts.

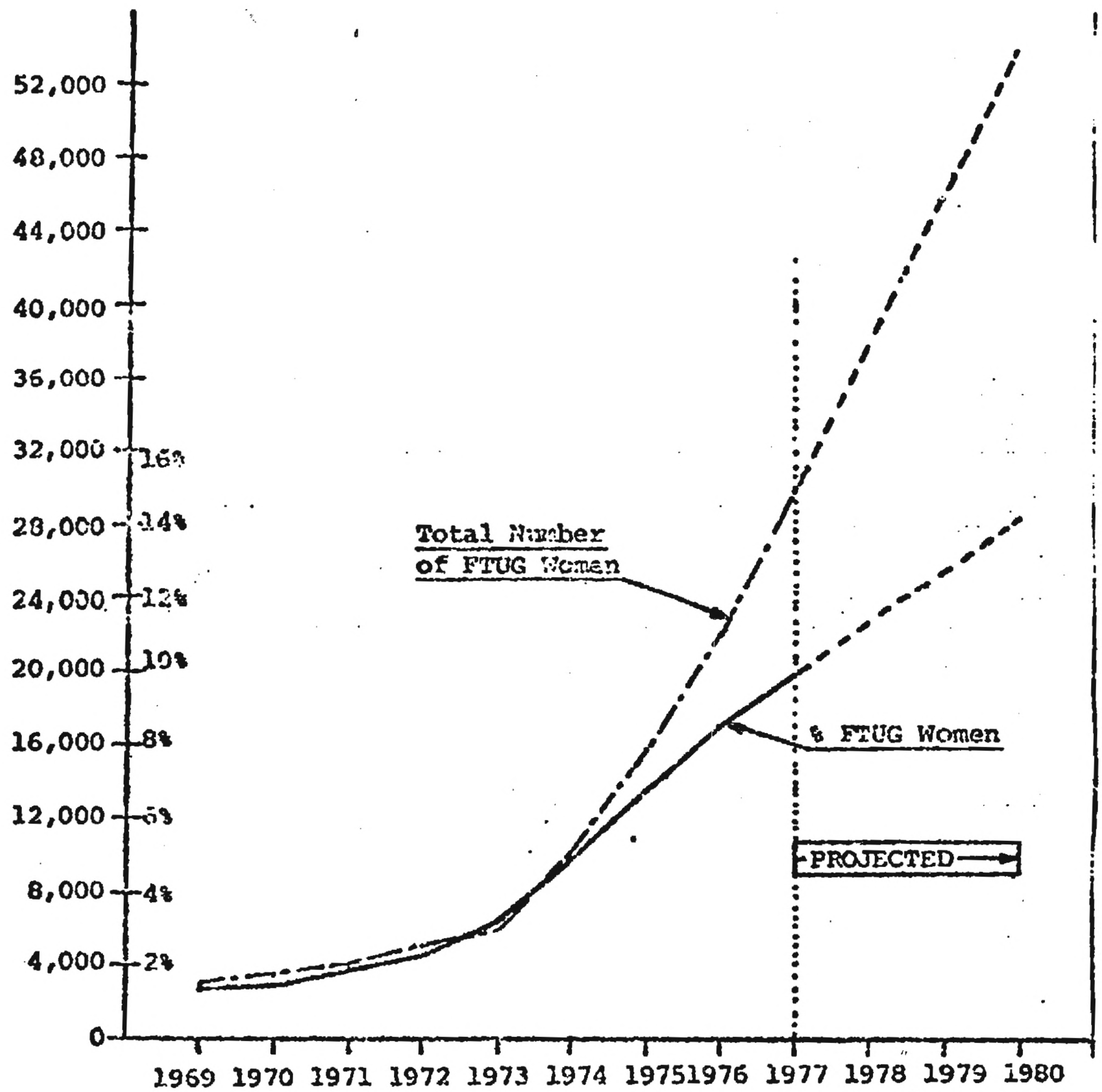
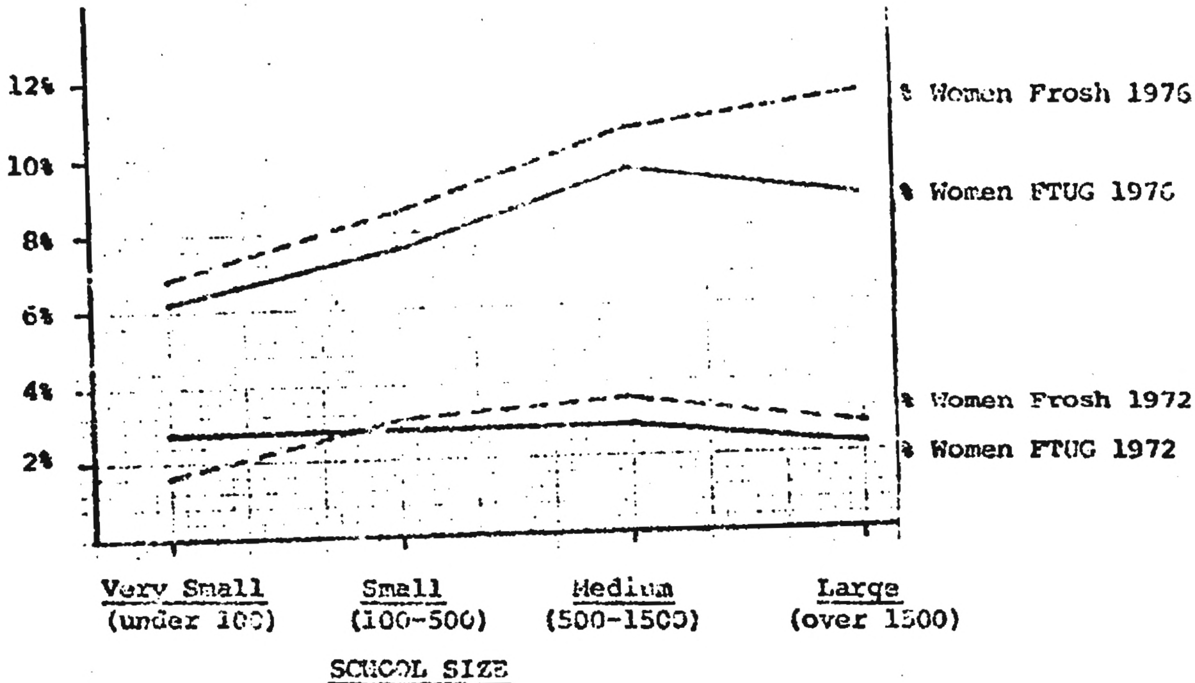


Figure 1: Total Numbers, and Percentage, of Full-Time Undergraduate (FTUG) Women in U.S. Engineering Schools, 1969-1977

(Source: EJC/EMC, Ref.2)



(based on Full-Time Undergraduates, Fall 1976)

Figure 2: Percentage Women in Engineering by School Size, 1972 and 1976.

(Source: EJC/EMC, Ref.1)

Table 1: Schools Included in Sample of 60 "Extreme Cases"

LARGE SCHOOLS (1500+ FTUG* in Engineering, Fall 1976)	MEDIUM-SIZED SCHOOLS (500-1500 FTUG* in Engineering, Fall 1976)	SMALL SCHOOLS (100-500 FTUG* in Engineering, Fall 1976)
High % WiE		
University of Pittsburgh	Prairie View A&M	SUNY College of Ceramics, Alfred
General Motors Institute	Vanderbilt University	Brown University
Michigan State University	Duke University	Southern Methodist Univers
Texas A and M	Washington University, MO	University of the Pacific
Massachusetts Inst. of Tech.	Stanford University	Tuskegee Institute
U. of California, Berkeley	University of Virginia	Boston University
Cornell University	Northwestern University	Swarthmore
U. of Michigan, Ann Arbor	Carnegie-Mellon University	U. of California, San Dieg
Colorado School of Mines	Princeton University	Harvard University
Lehigh University	Bucknell University	Humbolt State University
Low % WiE		
Iowa State University	U. of Wisconsin, Milwaukee	University of New Orleans
North Carolina State University	Polytechnic Inst. of NY, Brooklyn	Embry-Riddle Aero. Univers
West Virginia University	Tri-State College, IA	Indiana Institute of Technology
Drexel University	Cal. State U, Fresno	University of Bridgeport
California State Poly., Pomona	SUNY, Stony Brook	Gannon College
Northeastern University	North Dakota State University	Norwich University
California State Poly., San Luis	Wichita State University	Northrop University
Texas Tech. University	Laurence Institute of Tech.	Milwaukee School of Engineering
University of Lowell	Rochester Institute of Tech.	University of Evansville
City College of CUNY	U. of South West Louisiana	Letourneau College

*FTUG: Full-Time Undergraduate

Table 2: Popularity of Various WIE-oriented Program Activities

Program Activity	N of Schools	% of Total EJC Schools (N = 275)	% of Schools in ASEE Directory (N = 108)
1. Society of Women Engineers Section or Other Organization for Women Students in Engineering	95	35%	88%
2. Brochure, Leaflet, or Poster About Opportunities for WIE at the Named Institution	67	24%	62%
3. Scholarships or Merit Awards for Incoming Women Students	66	24%	61%
4. Special Program to Inform High School Counselors/Teachers about Opportunities for WIE	66	24%	61%
5. Summer Program for High School Students	54	20%	50%
6. Conference for Women in High School Held During Academic Year	44	16%	41%
7. Special Programs for Junior High School Students	24	9%	22%

Note: Information derived from ASEE survey (Ref. 4) and EJC compilations (Ref. 1).

Table 3: Relationship of WiE-oriented Activities to Women Enrollments

Program Activity	Average % Total WiE - 1976: Schools Indicating the Activity	Average % Total WiE - 1976: Schools Not Indicating the Activity	Average % Total WiE - 1976: Correlation (r) with % Total WiE for 1976 (r, controlling for school size)*	Average % Frosh WiE - 1976: Schools Indicating the Activity	Average % Frosh WiE - 1976: Schools Not Indicating the Activity	Average % Frosh WiE - 1976: Correlation (r) with % Frosh WiE for 1976 (r, controlling for school size)*
Inclusion in ASEE Directory	10.0% (108)	7.3% (167)		11.0% (108)	8.7% (167)	
Society of Women Engineers Section or Other Organization for Women Students in Engineering	10.3% (95)	7.9% (13)	.08 (.06)	11.4% (95)	7.7% (13)	-.15 (.07)
Brochure, Leaflet, or Poster about Opportunities for WiE at the Named Institution	10.4% (67)	9.4% (41)	.16 (.15)	11.2% (67)	10.6% (41)	.08 (.01)
Scholarships or Merit Awards for Incoming Women Students	9.3% (66)	11.1% (42)	.16 (.15)	11.4% (66)	10.4% (42)	.10 (.04)
Special Program to Inform High School Counselors/Teachers about Opportunities for WiE	10.2% (66)	9.7% (42)	.17 (.17)	10.6% (66)	11.6% (42)	.13 (.05)
Summer Program for High School Students	10.5% (54)	9.5% (54)	.21 (.22)	11.0% (54)	11.0% (54)	.20 (.12)

6. Conference for Women in High School Held During Academic Year	10.7% (44)	9.5% (64)	.15 (.14)	10.8% (44)	11.1% (64)	.08 (.00)
7. Special Programs for Junior High School Students	8.9% (24)	10.3% (84)	.03 (.01)	11.1% (24)	10.9% (84)	.07 (.03)

Note: Values in parentheses indicate N of schools. Percentages are an average of the percentage at each school in the respective grouping. Data are derived from the ASEE Survey (Ref. 4) and the EJC compilation (Ref. 1). By point of comparison, for each of the activities, one can compare with the % total WiE for schools not listed in the Directory - 7.3% (N = 167) - and with the % Frosh WiE for schools not listed - 8.7% (N = 167). Note that in nearly all cases, schools not indicating a given activity, but included in the Directory, do better than those not listed, possibly as a result of their other program activities whereas those not listed are unlikely to be doing much.

*Values shown are Pearson correlation coefficients; values in parentheses are partial correlation coefficients, controlling for size. Values over approximately .10 are significant ($p < .05$, one-tailed test).

Table 4: Level of WiE Recruiting Effort by Size of School* and by "Quality" of School**

(0 = None; 1 = Slight; 2 = Modest; 3 = Serious)

	Large	Medium	Small	High score	Low score	Total ($p < .09$)
High % Women	2.3	1.4	1.2	1.4	2.2	1.6
Low % Women	1.5	1.2	0.8	1.1	1.2	1.2
Total	1.9	1.3	1.0	1.4	1.4	1.4

*Large constitutes over 1500 full-time undergraduate engineering students; medium, 500-1500; and small, fewer than 500.

**"Quality" score is the SAT-Math equivalent for the college.

Table 5: Direct Mailings to Prospective Students

(0 = No; 1 = Yes)

	Large	Medium	Small	High score	Low score	Total (p < .01)
High % Women	.60	.40	.67	.58	.57	0.5
Low % Women	.40	.10	.10	.25	.17	0.2
Total	.50	.25	.37	.52	.26	0.4

Table 6: Opportunity for Direct Personal Contact with Prospective Students

(0 = None; 1 = Some; 2 = Good)

	Large	Medium	Small	High score	Low score	Total (n.s.)
High % Women	1.7	1.0	1.2	1.0	1.7	1.3
Low % Women	0.7	1.1	1.1	1.2	0.9	1.0
Total	1.2	1.0	1.1	1.1	1.1	1.1

Table 7: Reasons for Choosing Georgia Tech

(5-point scale: 1 = "No influence at all," 5 = "A major, decisive influence")

		Women Av.	Men av.	Sig.
1.	Georgia Tech's general reputation as a good engineering school.	4.7	4.7	ns
2.	Georgia Tech's specific reputation in my major field.	3.6	3.5	ns
3.	My parents (or relatives) think highly of Tech.	3.0	3.0	ns
4.	Tuition and living costs at Tech are relatively low for me.	2.8	2.7	ns
5.	Tech is small enough for me to get to know other students and faculty on a personal basis.	2.8	2.3	.01
6.	I wanted to live in Atlanta.	2.6	1.9	.01
7.	My high school counsellors (or teachers) think highly of Tech.	2.3	2.6	.10
8.	I knew someone who is (or was) at Tech.	2.2	2.1	ns
9.	I got an offer of financial aid from Tech.	2.1	1.5	.01
10.	I was directly contacted (by letter or phone) by a Tech recruiter.	1.9	1.4	.01
11.	I heard, or met with, a Georgia Tech recruiter.	1.7	1.5	ns
12.	I came to an on-campus academic program (e.g. a science fair) at Tech.	1.2	1.2	ns

Table 8: Some Differences Between Entering Men and Women Frosh at Georgia Tech

	Men	Women	Significant Difference?*
Getting financial aid from Georgia Tech.	19%	35%	Sig.
How important is financial aid?	2.8**	3.6	Sig.
Have not chosen a major field.	13%	27%	Sig.
I don't feel very well-prepared for the sort of work I will be doing at Tech.	2.4	2.9	Sig.
It's tough to get good grades at Tech.	3.9	4.2	Sig.
I'll get pretty upset if I find I am not doing well in a course.	3.9	4.3	Sig.
Pretty sure I will graduate from Tech, rather than transfer or drop out.	4.2	4.1	n.s.
I'm not at all sure Tech is the right school for me.	2.1	2.2	n.s.
Plan to co-op while at Tech.	31%	28%	n.s.
I will most probably do graduate work in engineering.	3.2	3.0	n.s.
How important is academic counseling?	3.9	4.3	Sig.
How important is personal counseling?	2.8	3.1	Sig.
How important is career counseling?	3.7	4.2	Sig.
How important are on-campus social, cultural and recreational facilities?	3.6	4.0	Sig.
It will be hard to make friends with other students.	2.2	2.0	n.s.
I'll probably study with other students whenever I can, rather than alone.	2.7	2.8	n.s.

Note: Tabled differences are for September (on entry) responses. Where these change in interesting ways, they are noted in the text (particularly note that some of the non-significant differences of September become significant by May).

*Significance ($p < .05$) is based upon simple grouped t-tests comparing means for men versus women. In that there are many items in the questionnaire, and May as well as September responses, these individual t-tests are not a conservative test of statistical significance when one is scanning over the whole set of items. Such a test is only (strictly) proper when one has an a priori hypothesis about a specific item.

**Numerical entries indicate a mean response on a scale from 1 (not at all important, strongly disagree, or similar negative sentiment) to 5 (extremely important, strongly agree, or similar positive sentiment). Responses are tallied for those Frosh who completed both September and May questionnaires (N = 120 men, 102 women).

Table 9: Support Activities for Women at the 60 "Extreme Case" Schools

A. Level of Overall Support Efforts for WiE
(0 = None ($\underline{N}$ = 27 schools); 1 = Minor (25); 2 = Major (7))

	Large	Medium	Small	High score	Low score	Total (n.s.)
High % Women	1.2	0.8	0.2	0.8	0.7	0.7
Low % Women	0.9	0.4	0.4	0.5	0.6	0.6
Total	1.0	0.6	0.3	0.7	0.6	0.65

B. Designated WiE Person
(0 = No ($\underline{N}$ = 41 schools); 1 = Partial (9); 2 = Yes (9))

						Total ($p < .01$)
High % Women	1.0	0.9	0.3	0.8	0.4	0.7
Low % Women	0.4	0.0	0.1	0.0	0.2	0.2
Total	0.7	0.4	0.2	0.7	0.3	0.45

C. Designated WiE Budget
(0 = No ($\underline{N}$ = 43 schools); 1 = Small (3); 2 = Yes (13))

						Total ($p < .01$)
High % Women	1.2	0.9	0.2	0.9	0.3	0.8
Low % Women	0.4	0.0	0.2	0.0	0.2	0.2
Total	0.8	0.4	0.2	0.7	0.3	0.5

D. Formal WiE Program
(0 = No ($\underline{N}$ = 45 schools); 1 = Some (9); 2 = Yes ( ))

						Total ($p < .01$)
High % Women	0.9	0.6	0.1	0.6	0.3	0.5
Low % Women	0.2	0.0	0.1	0.0	0.1	0.1
Total	0.5	0.3	0.1	0.5	0.2	0.3

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REFERENCES AND NOTES

1. "Engineering and Technology Enrollments, Fall 1967 - Fall 1977." New York, Engineers Joint Council, Engineering Manpower Commission (published annually). These reports carry a warning that data on women enrollments may be incomplete, particularly for the earlier years. We do not judge such incompleteness as large enough to invalidate the conclusions offered here.

2. Davis, S. O.: "Beyond Tokenism." New Engineer, Feb. 1978, pp. 22-29.

3. EJC/EMC data, Note 1 above. The 1976 data include 289 schools, those for 1972 include 275 schools. The smaller total is used in this paper when comparing across the two years.

4. American Society for Engineering Education (ASEE): "Women in Engineering: Directory of College/University Programs." Dated 1976.

5. Ott, M. D.: "Female Engineering Students: Attitudes, Characteristics, Responses to Engineering Education." Cornell University, College of Engineering, June 1978.

6. More evidence on this point is given in Connolly, T. and Burks, E. L.: "Women in Science and Engineering: Characteristics and Experiences of Established Professionals," Engineering Education, December 1977, pp. 234-240; and in the references cited there.